## *Calendar Dates in the Aramaic Papyri from Assuan.*

By J. K. Fotheringham.

(*Communicated by E. B. Knobel.*)

Those who are interested in ancient calendars and their astronomical significance will be grateful to Mr. Knobel for the close examination that he has given the dates in the Assuan papyri in the *Monthly Notices* of March 1908. Mr. Knobel's verification of these dates is in the majority of cases beyond controversy, and is a marked improvement on the dates given by Mr. Cowley from a mere reckoning by the years of Persian kings without reference to astronomical data. There are, however, two instances where it seems to me that Mr. Knobel's dates are capable of emendation, and I think it is also doubtful whether he is right in the calendar principles by which he attempts to explain them.

The papyri edited by Professor Sayce and Mr. Cowley * belong to a series of Aramaic papyri, which also includes three papyri edited by Professor Sachau † and translated into English by Canon Driver, ‡ and one papyrus edited by Professor Euting.§ All these papyri contain lunar dates with Aramaic month-names, but in those edited by Professor Sayce and Mr. Cowley these dates are accompanied by the corresponding dates of the Egyptian calendar, doubtless because they are all of the nature of contracts dealing with rights of property in Egypt, whereas the papyri edited by Professor Sachau and Professor Euting, which are of the nature of petitions to Persian authorities outside Egypt, contain none but the Aramaic month-names.

It has been assumed by all writers whose works have met my eye that the months with Aramaic names belong to the Jewish calendar, probably because the papyri belonged to a Jewish community. The argument does not appear to me to be conclusive. It is well known that these names are of Babylonian origin, and were not adopted by the Jews till the captivity, nor were they adopted by the Jews only, but also by the other peoples of Syria and Mesopotamia. || It may therefore be better to call these month-names Aramaic until it is determined to what calendar they belong.

A very brief inspection of the papyri will show that these Aramaic dates belong to a lunar calendar; and since the Egyptian calendar is well known, each year consisting of 365 days, it should be possible by a comparison of a table of Egyptian dates with a table of new moons to date precisely each papyrus that bears a double date, and to fix accurately the regnal years of Persian kings to which they are referred. The papyri that bear only an Aramaic

* *Aramaic papyri discovered at Assuan*, 1906.

† *Abhandlungen der königl. preuss. Akademie der Wissenschaften*, 1907.

‡ *The Guardian*, Nov. 6, 1907, p. 1827 f.

§ *Notice sur un papyrus Égypto-Araméen de la Bibliothèque impériale de Strasbourg*, 1903.

|| See Schiaparelli, *Astronomy in the Old Testament*, Oxford, 1905, p. 111.

date cannot by themselves be dated with the same precision, but as they too are assigned to definite regnal years, the other papyri do in effect enable us to date them also.

In Mr. Knobel's citations of the text of the papyri and his interpretation there is little which calls for criticism. I have examined each date in detail, and am inclined to accept Professor Schürer's conclusion in almost every case.* Professor Schürer and Mr. Knobel are, as will be seen, certainly right in accepting the higher numerals, bracketed by Mr. Cowley, as the only ones capable of bringing the chronology into any consistency. In papyrus B, where Mr. Knobel accepts Mr. Cowley's conjectural restoration of a lacuna with the date 6th. (7th.?) of Thoth, Professor Schürer prefers to read 17th. Again in papyrus J, where Mr. Knobel, following Mr. Cowley, reads 7th. (8th.?) for the year of Darius according to the Egyptian reckoning, Professor Schürer reads 9th. and Mr. Knobel has informed me that he now accepts this reading. In this case Mr. Cowley acknowledged that there seemed to be traces of an additional stroke, but preferred the reading 7th. (8th.?) in order to make the numeral agree with that in the Aramaic reckoning, not realising that the double insertion of the regnal year was due here, as in the following papyrus, to a difference between the Aramaic and the Egyptian reckoning.

To examine the dates more closely, we need, as I have suggested, a comparative table of the Julian and Egyptian calendars, such as is provided by Professor Mahler,† and also a table of new moons, such as is provided by Professor Ginzel.‡ Professor Ginzel gives the new moons in decimals of a day, reckoned from Greenwich mean noon. I have converted these into hours and minutes, reckoned from Assuan midnight. The addition of nine minutes more will convert these dates into Jerusalem time. Professor Ginzel's calculations are based upon Oppolzer's values for lunar and solar constants, and are made by means of Dr. Schram's Mondtafel.§ The method of calculation is far from exact, and the error may easily amount to the greater part of an hour. We have also to allow for possible errors in Oppolzer's values for the constants. By substituting Professor Newcomb's values ‖ for Oppolzer's we obtain a date three minutes later for the mean new moon of Elul, 471 B.C., and by substituting Mr. Cowell's values ¶ we obtain a date thirty minutes later than Oppolzer's for the same mean new moon. On the other hand, by substituting

* See his article in *Theologische Literaturzeitung*, Feb. 2, 1907. In one case I propose a correction of two days, and in one case I date a papyrus which he leaves undated. Otherwise my dates are the same as his.

† *Chronologische Vergleichungstabellen*—I. *Ägypt etc. griech.* 1888.

‡ *Handbuch der Chronologie* (1906), I, 551–3.

§ *Denkschriften der kaiserlichen Akademie der Wissenschaften Math.-naturw. Klasse*, xlv. (Vienna, 1882), reprinted in Schram's *Kalendariographische und Chronologische Tafeln*, 1908, pp. 356–9.

‖ I take these from Mr. Cowell's paper in *Monthly Notices*, lxv. (1905), p. 863.

¶ *Monthly Notices*, lxvi. (1906), p. 525.

Professor Ginzel's own values, we obtain a date twenty-three minutes earlier than Oppolzer's. For the mean new moon of Shebat, 410 B.C., these differences must be reduced to two minutes, twenty-eight minutes, and twenty minutes respectively. For the intervening new moons the corrections resulting from the substitution of these values will fall between the extremes just given. Mr. Knobel's lunar cycle must, I am afraid, be set aside, partly because we do not know that the calendar with which we are dealing is Jewish, partly because we have no accurate information about the Jewish calendar in the fifth century B.C., and partly because the initial date from which his supposed Jewish calendar is calculated, the eclipse of 14 Tammuz, 523 B.C., really belongs not to the Jewish, but to the Babylonian calendar. We must be content to assume in each case that the lunar month began near the new moon, and see what results from this. Taking the papyrus dates one by one, we get the following results:—

A. 17 (18) Elul = 27 (28) Pachons in 14 (15) Xerxes. The only date that could possibly correspond to 14 (15) Xerxes in which either the 27th. or 28th. of Pachons could be the 17th. or 18th. day of a lunar month is 471 B.C., when 27 (28) Pachons was the Julian 11 (12) September; so that we have 17 (18) Elul = 11 (12) September 471, 1 Elul = 26 August 471. Professor Ginzel gives for the new moon August $24^d\ 18^h\ 45^m$; if this is later than sunset, Elul would appear to have begun at the sunset after new moon. We also get 14 (15) Xerxes = 472–1 or 471–0.

B. 18 Chisleu (18 appears to be the correct figure) = 6 (7) [17 ?] Thoth in Xerxes 20 (21), beginning of Artaxerxes. Now if Xerxes 14 (15) is 472–1, Xerxes 20 (21), should be 466–5. 6 (7) Thoth would then be 23 (24) Dec. 466, and 17 Thoth would be 3 Jan. 465, impossible dates for the 18th of a lunar month, and exceedingly early for the accession of Artaxerxes. But if Xerxes 14 (15) is 471–0, Xerxes 20 (21) should be 465–4, the year beginning somewhere before Elul, presumably in Nisan, and 17 Thoth will be 2 Jan. 464. Mr. Knobel proposes to identify 6 (7) Thoth with 22 (23) Dec. 464, but Xerxes 20 (21) cannot be extended so late unless we suppose, firstly, that Xerxes 14 (15) is an error for Xerxes 13 (14), and, secondly, that the accession year of Artaxerxes is contrary to the Assyrian and Babylonian method of reckoning, the same as his "first year" and also the same as the 21st. year, the last regnal year, of his predecessor. These assumptions are, I think, too violent to be maintained. We are therefore compelled with Professor Schürer, to adopt the synchronism: 18 Chisleu = 17 Thoth = 2 Jan. 464. It will be observed that as 21 is always given as the last regnal year of Xerxes, the lower numbers, where Mr. Cowley gives us alternatives, already appear highly improbable; for if we were to accept them, the 20th. year of Xerxes would be the accession year of Artaxerxes. We now have 1 Chisleu = 16 Dec. 465, Chisleu beginning at the sunset after the new moon of Dec. $15^d\ 1^h\ 0^m$.

C is too much injured for the dates to be deciphered, but Mr.

Cowley appears to be right in suggesting that it is of the same date as D.

D. 21 Chisleu = 1 Mesore in 6 Artaxerxes. Mr. Knobel explains this on the bold assumption that 1 Mesore ought to be read 31 Mesore, and that 31 Mesore is a name, found nowhere else, for the first Epagomene. He also assumes that 6 Artaxerxes is at latest 460–459, four years later than the year which he identifies as the accession year of Artaxerxes, and, as will be seen hereafter, fourteen years earlier than 19 Artaxerxes. If he had, with Professor Schürer, chosen a date only one lunar month earlier, the most difficult of these assumptions would have been obviated. We then have 21 Chisleu = 1 Mesore = 11 Nov. 460. 1 Chisleu is then = 22 Oct. 460, and Chisleu begins at the sunset following the new moon of Oct. $21^d\ 2^h\ 12^m$. The 6th. year of Artaxerxes is, however, still 460–459, five years after his accession year, but 14 years before what we shall find enumerated as his 19th. year. On either Mr. Knobel's or Professor Schürer's assumption, it appears to be necessary to correct the 6th. year to the 5th., but Professor Schürer's hypothesis involves no further difficulty, and may be accepted as correct.

E. 3 Chisleu = 10 Mesore in 19 Artaxerxes. Both Professor Schürer and Mr. Knobel identify this with 17 Nov. 446. This would give us for 1 Chisleu 15 Nov. 446, and Chisleu would begin at the second sunset before the new moon of Nov. $16^d\ 6^h\ 2^m$, a surprising result, which we should nevertheless be compelled to accept were there not other evidence, to be mentioned hereafter, pointing to an error in this date. For 19 Artaxerxes we get 446–5, agreeing with an accession year of 465–4, but not with a 6th. year of 460–59.

F. 13 (14) Ab = 19 Pachons in 25 Artaxerxes. This is indisputably = 26th August 440. 1 Ab is therefore 14 (13) August. The date of the new moon is given by Professor Ginzel as Aug. $12^d\ 19^h\ 28^m$, so that if we accept the reading 14 Ab, as seems to follow from the regnal years of Xerxes above, Ab would appear to begin at a sunset almost simultaneous with new moon, if anything slightly preceding it. The difference between the two is apparently within the range of error of Professor Ginzel's tables, of ancient Babylonian computations, and even of modern theory. 25 Artaxerxes is clearly 440–39.

G. 26 Tishri = 6 Epiphi. The number of the year is lost here, but Mr. Cowley argues that it cannot be earlier than 446 or later than 440. He himself prefers 440. As his dates for papyri E and F are confirmed by our astronomical investigations, we may accept these dates as they stand. Professor Schürer abandons the attempt to date this papyrus. Mr. Knobel proposes 14 Oct. 446. The only dates astronomically possible appear to be 14 Oct. 446 and 13 Oct. 443. The former gives for 1 Tishri 19 Sept. 446, the month beginning at the sunset after the new moon of Sept. $17^d\ 18^h\ 31^m$, and the latter gives 18 Sept. 443, the month beginning at the fourth sunset after the new moon of Sept. $13^d\ 22^h\ 48^m$.

As nearly all the dates in the series involve a commencement of the lunar month at the sunset immediately following the new moon, I prefer to accept Mr. Knobel's date, in spite of a further difficulty which it involves. We now have in 446 the two dates 26 Tishri and 3 Chisleu separated by only 34 days, but even if we suppose that in this year both Tishri and Marheshvan were 29-day months the interval ought to be 35. If either had 30 days, as was probably the case, the interval should be 36. Now, Chisleu appears in D to begin two days too soon, on the second evening before the new moon instead of on the evening after the new moon. There are therefore two independent reasons for assuming an error of two days in the date of E, and for correcting either 3 Chisleu to 1 Chisleu or 10 Mesore to 12 Mesore. It will be observed that this error is assumed as much by Mr. Knobel's theory as by my own, in spite of Mr. Knobel's protestation against assuming any error in the dates contained in these papyri. It may be remarked that errors in other parts of the papyri are not uncommon.

H. Elul = Payni in 3 (4) Darius. Payni, as Mr. Knobel points out, would in 420, which is the most probable date, run from 2 September to 1 October, and is almost conterminous with a lunar month. This does not permit us to fix the beginning of the month with certainty, but renders September 29 the probable date for the new moon of Tishri.

J. 3 Chisleu, 7 (8) Darius = 11 (12) Thoth, 7 (8) [9?] Darius. If, as Professor Schürer suggests, and as seems probable, 9 is the correct reading in the Egyptian date, we have the regnal year repeated, because it was different in the two calendars used. The date is clearly 15 (16) Dec. 416, so that 1 Chisleu is 13 (14) Dec. If we accept the higher figure, as seems to be indicated by the date in B, and as will be seen by the date in K, Chisleu will begin at the sunset following the new moon of Dec. $12^d\ 23^h\ 33^m$. The 8th. year of Darius, according to the Aramaic reckoning, will be 416–5; and if we accept Professor Schürer's reading, the 9th. according to Egyptian reckoning will also be 416–5.

K. 23 (24) Shebat; 13 Darius = 8 (9) Athyr, 13 (14) Darius. The date here is clearly 10 Feb. 410, five years later than J., whether we begin the year in Nisan, in Tishri, or in Thoth. This makes it clear that 8, not 7, was the correct figure for the Aramaic year in J., so that the higher figures bracketed by Mr. Cowley are to be preferred to the lower figures in his text. The Aramaic 13 Darius and the Egyptian 14 Darius must both be 411–0, the former apparently beginning in Nisan,* the latter in Thoth. If 24 Shebat = 10 Feb., 1 Shebat will be 18 Jan., the month beginning at the sunset after the new moon of Jan. $17^d\ 3^h\ 9^m$.

This finishes the dates on the papyri edited by Professor Sayce and Mr. Cowley, but the data thus obtained enable us to date the remaining papyri more closely than would be otherwise possible. Tammuz in the 14th year of Darius, mentioned in the papyrus

* From the comment on B above, it appeared that the Aramaic years began somewhere before Elul.

edited by Professor Euting, and in the first and third of those edited by Professor Sachau, clearly belongs to 410 B.C., while 20 Marheshvan in the 17th year of Darius, on which the second and third of Professor Sachau's papyri are dated, just as clearly belongs to 407 B.C.

It may be well to arrange in parallel columns the dates proposed by Mr. Cowley, and those supported in the present article, to show how far the astronomical investigation affects the dates of the papyri.

| Papyrus. | Mr. Cowley's Date. | Date now proposed. |
|---|---|---|
| A | 471 | 471 Sept. 12 |
| B | 465 | 464 Jan. 2 |
| C | 459 | 460 Nov. 11 (?) |
| D | 459 | 460 ,, 11 |
| E | 446 | 446 ,, 17 (19?) |
| F | 440 | 440 Aug. 26 |
| G | 440 | 446 Oct. 14 |
| H | 421 | 420 Sept. |
| J | 417 | 416 Dec. 16 |
| K | 411 | 410 Feb. 10 |

The next problem is to determine how far the dates obtained in the foregoing inquiry enable us to infer a theory of intercalation. Professor Schürer has calculated the date of 14 Nisan from each of the dates above. In order to compare better with Mr. Knobel's table, I have preferred to compute the new moon of Tishri, assuming in each case that Tishri is not preceded by an intercalary month, as it sometimes is in the Babylonian calendar. The dates given below are those of the astronomical new moon, as given in Professor Ginzel's tables.

| Year B.C. | New Moon of Tishri. |
|---|---|
| 471 | 23 Sept. |
| 465 | 16 Oct. |
| 460 | 23 Aug. |
| 446 | 17 Sept. |
| 440 | 10 Oct. |
| 420 | 29 Sept. |
| 416 | 14 Oct. |
| 411 | 20 Sept. |

All these dates except 23 Aug. 460 are consistent with a systematic intercalation. But even if we could abandon the August date, it would not follow that the intercalations were actually governed by rule, and not by the discretion of an authority possessing some astronomical knowledge. But the August date suggests that the intercalations were not regular. Professor Schürer thinks that they were determined on principles similar to

those which guided the sanhedrim at a later date when the weather and the state of the crops were considered as well as the course of the sun. For my own part, I cannot but think of the irregular intercalations of the Babylonian calendar, as proved by the contract tablets used by the late M. Oppert.* M. Oppert believed that the regular intercalations of the 19 years cycle were disturbed from time to time by the natural desire to prevent important astrological phenomena from falling on unlucky dates. Whatever the cause, the fact appears to be certain; and I should have inferred that the dates in these papyri were Babylonian but for a difficulty that will be mentioned later.

It will have been observed that, with two doubtful exceptions (E and F), all the lunar months in these papyri begin with the sunset following the new moon. The exception in E appears, as has been seen, to be due to an error in the papyrus, and when corrected, confirms the rule. If we substitute the mean new moon for the true new moon, we get rid of the exception in F. There we have 1 Ab = 13 August 440, with August $12^d\ 19^h\ 28^m$ as the date of new moon. Dr. Guinness † gives for the mean new moon August $12^d\ 14^h\ 7^m$, Jerusalem mean time reckoned from midnight, so that if mean new moons were the basis of this calendar and not true new moons, the exception would disappear. On the other hand, the mean new moon in K might possibly be a little too early. Dr. Guinness gives for this 410 January $16^d\ 17^h\ 23^m$, whereas 1 Shebat is 18 January. The date given by Dr. Guinness falls just after sunset at Jerusalem, but before sunset at Assuan; it must, however, be remembered that the modern Jewish calendar is calculated on the basis of a mean sunset at 6 p.m., and a calendar based on a mean new moon would probably also be based on a mean sunset.

Most of the modern values for lunar and solar constants would give a slightly earlier date. Reckoning by means of Oppolzer's tables with Hansen's constants, I get $4^h\ 25^m$ p.m. Assuan mean time; with Professor Ginzel's constants I get $4^h\ 48^m$, with Oppolzer's $5^h\ 8^m$, with Professor Newcomb's $5^h\ 10^m$, and with Mr. Cowell's $5^h\ 24^m$. The last of these would give $5^h\ 33^m$ p.m. for Jerusalem.

It is far from certain, however, how the compilers of an ancient calendar would reckon the mean new moon. The modern Jewish calendar would give $17^h\ 14^m$ (Jerusalem time) as the date of mean new moon on 16 January 410 B.C., but it is not likely that the mean new moons of the modern calendar are older than the great calendar reform of the fourth century A.D., though it is surprising that the date should be so accurate at such a distance of time.

* See his article, "La fixation exacte de la chronologie des derniers rois de Babylone," *Zeitschrift für Assyriologie*, 1893, pp. 56–74. Professor Ginzel gives a list of all known intercalary years in the Babylonian calendar, *Handbuch der Chronologie*, I pp. 133, 134. They clearly do not conform to a nineteen years' cycle.

† *Creation centred in Christ*, Astronomical Appendix (1896).

The question then arises whether it is possible to fix the mean new moon later than 6 p.m. on 16 January 410, without moving any of the other mean new moons from one day to the next, and, if so, what value the authors of this calendar used for the mean lunation. Of all the other mean new moons in the series earlier than 6 p.m., the one that comes nearest to that hour is the mean new moon of 21 October 460, which Dr. Guinness gives as $14^h\ 14^m$, and which the modern Jewish calendar dates $14^h\ 16^m$. This mean new moon need only be transferred to $15^h\ 2^m$, still well before sunset, if the mean new moon of 16 January 410 is to be transferred to 6 p.m. There is, therefore, no difficulty in supposing that the Aramaic months began at the sunset following mean new moon; and it is, of course, easier to suppose that those who had control of the calendar calculated the mean new moon than the true new moon. I have made a further investigation to see what duration of the synodical month is involved in these dates, on the supposition that no month begins before the mean new moon, and none more than twenty-four hours after the mean new moon. I find that these dates can only be reconciled with such a principle on the supposition that the synodical month was reckoned at not less than $29^d\ 12^h\ 43^m\ 53^s{\cdot}50$, and not more than $29^d\ 12^h\ 44^m\ 51^s{\cdot}15$. This calendar implies, therefore, a more exact value for the lunation than that adopted by the Greek astronomer Meton in 432 B.C. No such exact calculation seems to have been propounded in Greece before the time of Callippus, whose first cycle began in 330 B.C. But a value for the synodical month falling within the limits mentioned could be inferred at once from the eighteen years cycle of eclipses, and must have been known wherever that cycle was used. The knowledge necessary for the prediction of eclipses was possessed by Thales in 585 B.C., and must have existed at Babylon at an earlier date.

But this calendar is not Babylonian. All our evidence seems to show that the Babylonian months began with the first appearance of the crescent, though whether at the calculated or at the empirical date of the appearance is not so certain. In the Babylonian tables of appearances of the moon published by Epping,* the interval between new moon and the first appearance of the crescent varies from 18·8 hours to 52·2 hours, and only on two occasions out of thirty-three does the moon appear at the first sunset after the new moon. It follows that the months on these papyri generally began one day earlier than the Babylonian months. But if the calendar was not Babylonian, neither was it the same as that used by the Jews in the age preceding the Mishna. The Jews of that period found the beginning of the month by simple observation, and therefore this theory, though maintained by Professor Schürer, is open to the same objection as that which would regard the dates as Babylonian. The calendar rules suggested by Mr. Knobel will not hold, because in only two instances do they give exactly the same dates as those of the papyri. I have tested the modern

* *Astronomisches aus Babylon* (1889), pp. 18–24.

Jewish rules, by which each day of the year can only fall on one or other of certain days of the week, and by which the different months, with the exception of Marheshvan and Chisleu have fixed durations, Tishri alone being computed directly from the mean new moon; and I find that neither of these rules will apply to the calendar dates before us. It remains that these dates belong to a hitherto unknown calendar, where intercalation appears to be more or less arbitrary, but where the length of each month is rigidly fixed by the rule that each begins at the sunset after the mean new moon. The mean new moon may have been simply calculated from an astronomical value, or a cycle may have been framed which would give effect to the rule. The shortest such cycle, consistent with the length found above for the synodical month, would be one of 49 months, based on a value (as it happens, a very accurate value) of $29\frac{26}{49}$ days for the lunation. Such a cycle would be composed of two periods of 17 months and one of 15. If we arrange each of these periods with months of 29 and 30 days alternately, beginning each period with a 29-day month, and giving the last month of each period 30 days instead of 29, and if we place the 15-month period last of the three, the calendar dates of these papyri will be found to accord with such a cycle, on the assumption that the first month mentioned on our papyri, Elul 471 B.C., is the 6th, 8th, 23rd, 25th, 38th, 40th, or 42nd of the cycle. Working with such a cycle, and assuming that the new moon of Tishri 407 B.C., like all but one of the Aramaic Tishris that we have been able to date, falls not earlier than 17 September, nor later than 16 October, we find that 20 Marheshvan 407 in the second and third of Professor Sachau's papyri, the one exact Aramaic date which is given without a corresponding Egyptian date, will be either 24 November or 25 November 407 B.C.

This calendar, whether its dates were computed by direct astronomical calculation or by a lunar cycle, is clearly much more scientific than the merely empirical rules used by the Jews of the first and second centuries of our era. If this was the calendar of the Jews of Palestine, their calendar must have afterwards developed in a retrograde direction. It seems easier to suppose that as the Jews of Elephantine had a temple of their own, they had their own council of priests or elders who regulated the beginning of the month by strict rules and the beginning of the year according to their own discretion. Whether the astronomical knowledge involved was acquired from Egypt or from Babylon, I cannot say. We have not, so far as I know, any evidence as to the Egyptian value for the synodical month at the date to which these papyri belong.

12 *Holywell, Oxford*:
1908 *July* 25.

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## *Oppolzer's and Ginzel's Corrections to Hansen.*

By J. K. Fotheringham.

Oppolzer, in his *Syzygientafeln* (1881), p. 15, proposes certain corrections to Hansen's values for the mean motions and accelerations of the Moon. As these corrections have been applied in the calculation of Oppolzer's *Canon der Finsternisse* (1887), it is important that they should be correctly interpreted by those who have occasion to use the *Canon der Finsternisse.*

Oppolzer gives his corrections in the form—

$$\begin{aligned} \Delta T &= +0{\cdot}0006\,s \quad +0{\cdot}00009\,s^2 \quad +0{\cdot}000\;\;00009\,s^3 \\ \Delta(g+\omega) &= -0^\circ 019\,s \quad -0^\circ 0004\,s^2 \quad -0^\circ 000\;\;0004\,s^3 \\ \Delta g &= \qquad\qquad\;\; +0^\circ 003\,s^2 \quad +0^\circ 000\;\;003\,s^3 \end{aligned}$$

where $s$ is the interval in centuries since 1800·0,
T is the time of mean syzygy expressed in decimals of a day,
$g$ is the mean anomaly of the Moon,
$\omega$ is the longitude of lunar perigee measured from the ascending node.

As Oppolzer's tables exist for the purpose of computing the elements of a syzygy, not of constructing an ephemeris, his corrections naturally apply to the moment of mean syzygy, not to a fixed moment of time; further, since his tables express $g$ in centesimal degrees, and $g+\omega$ in sexagesimal degrees, it seems reasonable to suppose that the corrections are expressed in the same form. In order to make sure that these principles of interpretation are correct, I have computed the corrections for −101 and −462, and find that they only agree with the corrections actually applied if interpreted as described above. Unfortunately, Oppolzer gives no warning as to the interpretation of his corrections, and they have in consequence been frequently misunderstood. The misunderstanding is rendered the easier by the use of the symbol ° for centesimal degrees. I have not found any other passage in Oppolzer where that symbol is used for any but sexagesimal degrees.

Professor Ginzel, in his *Astronomische Untersuchungen über Finsternisse* in *Sitzungsberichte der kaiserlichen Akademie der Wissenschaften math. naturw. Classe*, lxxxix. (2), (1884), uses Oppolzer's *Syzygientafeln* as the basis of his corrections, and, while realising that the corrections are to be applied to the moment of mean syzygy, interprets $\Delta g$ as if it were expressed in sexagesimal degrees. The corrections thus obtained are, however, tested by the eclipses used and made the basis of further corrections, which are not affected by the misunderstanding of Oppolzer's $\Delta g$. Dr. Schram, in his *Reductionstafeln* (*Denkschriften der k. Akademie der W. math. naturw. cl.*, lvi.) (1889), in reducing Professor Ginzel's